# MORPHOMETRY OF SCULPINS (*COTTUS*) IN THE CLEARWATER DRAINAGE, IDAHO

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ABSTRACT.— The morphometry of four Idaho species of Cottidae were compared. Pectoral ray counts allowed separation of *Cottus beldingi* and *C. confusus* from *C. bairdi* and *C. rhotheus* but not from each other. Preopercular armature also allowed identification of the same two groups of two species. Palatine tooth development generally allowed separation of each species as did body prickle development. Body ratios involving caudal peduncle depth allowed separation of *C. rhotheus* and *C. bairdi*. Development of lateral lines allowed differentiation of *C. rhotheus* from the other three species. A key was developed based on the combination of characters studied.

Geographic variation within the genus *Cottus* is a complex phenomenon that has hampered taxonomic comparisons for many years. Robins and Miller (1957) considered variation in the genus to be often haphazard. As a result of such variation, interpretation of species limits was difficult if not impossible. McAllister and Lindsey (1961) considered the freshwater sculpins of western North America to form an intriguing and perplexing mosaic of forms where convergent and divergent evolution confused the efforts of systematists to distinguish species and to discern relationships among species. Most systematists agreed that progress in understanding this genus depended on the accumulation of data describing variation of each form over the whole geographic range. Early attempts at cataloging information on geographic variation in cottids were accomplished by Bailey and Bond (1963), McAllister and Lindsey (1961), Robins and Miller (1957), and Koli (1969a).

In 1968-1970, I undertook an analysis of variation in sculpins within the Clearwater drainage system in northcentral Idaho. The objectives of the study were to collect data on variation that could serve as a contribution for evaluation of these species over their entire range.

## METHODS

Sculpins were collected with a backpack electroshocker from 114 locations in the Clearwater drainage (Maughan 1976). Ten fish of each species from each location were examined. Twenty-six primary and 36 derived characters were selected for analysis. The characters selected were from Robins and Miller (1957) and/or McAllister and Lindsey (1961). Morphometry followed the methods of Robins and Miller (1957) except that all paired fin counts were made from the right side of the fish (Maughan 1974). Sex was determined by examination of the genital papilla. Analysis was designed to determine the characters most useful to identify species, the extent of character variation within a species, and the degree of overlap among species.

## RESULTS

Four species of Cottidae were taken from the Clearwater drainage system. They were *Cottus bairdi* Bailey and Dimick, *C. beldingi* Eigenmann and Eigenmann, *C. confusus* Bailey and Bond, and *C. rhotheus* (Smith). Distributions overlapped for three of the species, but *C. confusus* was generally found further toward the headwaters than the other species (Maughan 1976).

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*Color.*— Color and color pattern has been widely used as a taxonomic character for sculpins (Robins 1954, Williams and Robins 1970). Color of Clearwater cottids mimicked substrate color and showed no consistent pattern.

*Spinous dorsal color.*— A black blotch in the front and the rear of the spinous dorsal (*C. bairdi* species group) or a blotch only in the rear of the fin (*C. asper* species group), or a banded or a mottled fin (*C. carolinae* species group) has been used to separate species groups of sculpins (Bailey and Bond 1963). *Cottus bairdi*, *C. beldingi*, and *C. confusus* belong to the *C. bairdi* species group, whereas *C. rhotheus* belongs to the *C. carolinae* species group.

Clearwater *C. confusus* usually lacked black blotches on the fin; but, if blotches were present, they were found at both the front and the rear of the fin. Occasional fish had a black bar in the fin. A black blotch at the front and the rear of the fin, a black band through the fin, or a black blotch at the front and rear connected by a black band was the range of conditions in *C. beldingi*. *Cottus bairdi* had either a black bar through the fin or two black blotches connected by a black band. The fin was banded, mottled, or had scattered melanophores along the fin rays in *C. rhotheus*. Occasional fish had black-barred or black-blotched spinous dorsals. These fish were normally breeding males. When black blotches were present, they were usually present at both the front and the rear of the fin. The color of the spinous dorsal overlapped in all the species studied and did not allow separation of species.

*Dorsal saddles.*— The number of dorsal saddles has been used to identify cottid species (Bailey and Dimick 1949). The basal number is six saddles: two under the spinous dorsal, three under the soft dorsal, and one crossing the caudal peduncle. Occasionally, there are four saddles under the soft dorsal.

Five or six saddles (mean 4.7, S.E. 1.4) were usually present in *C. confusus*. The saddle crossing the caudal peduncle was generally absent. Usually the first spinous dorsal saddle was also absent from South Fork and North Fork Clearwater fishes. Five, six, or seven saddles (mean 5.3, S.E. 1.7) were present in *C. beldingi*. *C. bairdi* usually had six dorsal saddles (mean 5.9, S.E. 0.4), but a seventh saddle was sometimes present. *Cottus rhotheus* usually had fewer saddles (mean 4.8, S.E. 0.6) than the other species except *C. confusus*. The first spinous dorsal saddle and the second soft dorsal saddle were commonly absent in *C. rhotheus*, with the caudal peduncle saddle sometimes absent. The saddles ran cephalad at about 60 degree angles to the horizontal axis in *C. rhotheus* but were perpendicular to the horizontal axis in the other three species.

*Palatine teeth.*— The development of palatine teeth has been widely used to separate species and species groups of sculpins. The variability of this character is not generally extensive, although some variability is encountered.

*Cottus confusus* had been reported to have weakly developed palatine teeth and show very little variability in the development of palatine teeth. Bailey and Bond (1963) examined over 500 specimens of this species and found only one individual that lacked palatine teeth. Weakly developed palatine teeth were present in my specimens except some from Squaw Creek (tributary to the Lochsa) and from the upper Selway. Approximately 70 percent of the specimens from the headwaters of Squaw Creek lacked palatine teeth, and 10 percent had teeth only on one side. All specimens at this location had the axial prickle pattern typical of *C. confusus*. About 20 percent of the fish at the mouth of Squaw Creek were without palatine teeth, and 30 percent had teeth on only one side. Two fish from the upper Selway River lacked teeth, and two fish had teeth only on one side.

*Cottus beldingi* normally lacks palatine teeth, although the type specimen had teeth (Eigenmann and Eigenmann 1891). All individuals from the Clearwater lacked palatine teeth except for 3 percent of the fish from Lapwai Creek, which had palatine teeth on one or both sides. Specimens of *C. beldingi* from Lolo Creek near Musselshell Ranger Station lacked palatine teeth but one individual had body prickles. Possibly, this population was the result of hybridization of *C. beldingi* and *C. confusus*.

The palatine teeth in *C. bairdi* and *C. rhotheus* from the Clearwater were extensively developed. *Cottus rhotheus* usually had the palatine and vomerine teeth conjoined, whereas *C. bairdi* showed a slight separation between the tooth patches.

The presence or absence of palatine teeth plus the degree of development were sufficient to separate the four species from the Clearwater, with the exceptions discussed above.

*Sex.*— The number of males was slightly greater than the number of females taken in all species but was not significantly different from a one-to-one ratio. Bailey (1952) and Smyly (1957) found that males were more abundant in deeper water, and females were more abundant in shallow waters (less than 18 inches). The slight propensity toward males in my collection may reflect a tendency to sample deeper waters, although an attempt was made to sample all habitats with equal intensity.

*Meristic characters.*— Meristic or countable characters have long been used for systematic studies. Pelvic fin rays, pectoral fin rays, anal fin rays, soft dorsal fin rays, and spinous dorsal fin rays were counted in this study (Table 1). Values obtained varied only slightly from values previously reported (*C. bairdi*, Bailey and Dimick 1949; *C. confusus*, Bailey and Bond 1963; *C. beldingi*, Eigenmann and Eigenmann 1891, Hubbs and Schultz 1932; and *C. rhotheus*, Smith 1882, Bailey and Dimick 1949). However, 30 percent of the specimens of *C. beldingi* did have pelvic ray counts of 1, 3.

Counts would not separate the four Clearwater species. The mean number of pectoral rays generally separated the species into two groups of two species, but there was some overlap in ranges. Other counts showed slight differences in modes, but these differences were insignificant when compared to the ranges.

*Body proportions.*— Thirty-six proportions were analyzed to determine whether any single proportion would allow separation of species (Table 2). Several proportions allowed division of fish into overlapping groups, but only ratios involving caudal peduncle depth allowed identification of *C. rhotheus* and *C. bairdi*. *Cottus confusus* and *C. beldingi* were not separated from each other by any proportions.

*Body prickles.*— The degree of body prickling is a character used in cottid taxonomy (Robins and Miller 1957, Koli 1969b, Oliva and Hensel 1962), although variability is commonly related to habitat and age (Robins and Miller 1957, Koli 1969a, Krejsa 1965). The prickling pattern was typical for most representatives of all species (Table 3) (*C. beldingi*, Eigenmann and Eigenmann 1891; *C. confusus*, Bailey and Bond 1963; *C. bairdi*, Bailey and Dimick 1949; *C. rhotheus*, Bailey and Dimick 1949). Exceptions were found since one specimen of *C. beldingi* had two prickles in the axial position and the prickling pattern of larger specimens of *C. rhotheus* approached the condition typical of *C. bairdi*. These specimens of *C. rhotheus* may represent older fish that have begun to resorb prickles since prickle resorption with maturity is apparently a common phenomenon in other species of the genus (Krejsa 1965, Koli 1969a).

The prickling pattern within each of the four species was relatively constant within the Clearwater specimens. The greatest variability occurred in *C. rhotheus*, but this variation was related to size and not to location.

*Preopercular-mandibular canal.*— The preopercular-mandibular canals are composed of a preopercular canal and a mandibular

TABLE 1. Mean number of fin rays in each of four species of Clearwater Drainage cottids.

| Species | Sample size | Pectorals | | Anal | | Soft dorsal | | Spinous dorsal | |
|---|---|---|---|---|---|---|---|---|---|
| | | Mean | S.E. | Mean | S.E. | Mean | S.E. | Mean | S.E. |
| *C. confusus* | 219 | 13.3 | 0.6 | 13.0 | 0.7 | 17.2 | 0.7 | 8.1 | 0.3 |
| *C. beldingi* | 546 | 14.0 | 0.5 | 11.9 | 0.5 | 17.2 | 0.7 | 7.6 | 0.9 |
| *C. bairdi* | 227 | 15.6 | 0.5 | 12.6 | 0.6 | 17.0 | 0.6 | 7.7 | 0.4 |
| *C. rhotheus* | 316 | 16.0 | 0.5 | 12.1 | 0.5 | 16.1 | 0.6 | 8.1 | 0.5 |

TABLE 2. Mean values for body ratios of each of 4 species of cottids. $R_1$ = standard length/total length, $R_2$ = head length/total length, $R_3$ = longest soft dorsal ray/total length, $R_4$ = longest soft dorsal ray/total length, $R_5$ = body depth/total length, $R_6$ = caudal peduncle depth/total length, $R_7$ = mouth width/total length, $R_8$ = head width/total length, $R_9$ = head length/standard length, $R_{10}$ = longest soft ray/standard length, $R_{11}$ = longest spinous ray/standard length, $R_{12}$ = body depth/standard length, $R_{13}$ = caudal peduncle depth/standard length, $R_{14}$ = mouth width/standard length, $R_{15}$ = head width, standard length, $R_{16}$ = longest soft ray/head length, $R_{17}$ = longest spinous ray/head length, $R_{18}$ = body depth/head length, $R_{19}$ = caudal peduncle depth/head length, $R_{20}$ = mouth width/head length, $R_{21}$ = head width/head length, $R_{22}$ = longest soft ray/head width, $R_{23}$ = longest spinous ray/head width, $R_{24}$ = body depth/head width, $R_{25}$ = caudal peduncle depth/head width, $R_{26}$ = mouth width/head width, $R_{27}$ = longest soft ray/mouth width, $R_{28}$ = longest spinous ray/mouth width, $R_{29}$ = body depth/mouth width, $R_{30}$ = caudal peduncle depth/mouth width, $R_{31}$ = longest soft ray/body depth, $R_{32}$ = longest spinous ray/body depth, $R_{33}$ = caudal peduncle depth/body depth, $R_{34}$ = longest soft ray/caudal depth, $R_{35}$ = longest spinous ray/caudal peduncle depth, and $R_{36}$ = longest spinous ray/longest soft ray.

| | $R_1$ | $R_2$ | $R_3$ | $R_4$ | $R_5$ | $R_6$ | $R_7$ | $R_8$ | $R_9$ | $R_{10}$ | $R_{11}$ | $R_{12}$ | $R_{13}$* | $R_{14}$ | $R_{15}$ | $R_{16}$ | $R_{17}$ | $R_{18}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *C. bairdi* N=219 | .81 | .28 | .13 | .09 | .19 | .06 | .19 | .26 | .32 | .17 | .11 | .24 | .08 | .23 | .36 | .48 | .33 | .69 |
| *C. beldingi* N=546 | .81 | .26 | .12 | .07 | .18 | .08 | .16 | .24 | .30 | .15 | .09 | .22 | .10 | .20 | .31 | .46 | .27 | .69 |
| *C. confusus* N=227 | .81 | .24 | .12 | .08 | .17 | .07 | .15 | .22 | .26 | .15 | .10 | .21 | .09 | .19 | .29 | .49 | .32 | .69 |
| *C. rhotheus* N=219 | .81 | .29 | .14 | .09 | .19 | .05 | .21 | .28 | .35 | .17 | .11 | .23 | .06 | .26 | .37 | .47 | .30 | .64 |

| | R19 | R20 | R21 | R22 | R23 | R24 | R25* | R26 | R27 | R28 | R29 | R30* | R31 | R32 | R33* | R34 | R35* | R36 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *C. bairdi* N=219 | .23 | .67 | 1.05 | .47 | .32 | .66 | .22 | .64 | .74 | .50 | 1.0 | .34 | .70 | .48 | .33 | 2.14 | 1.47 | .69 |
| *C. beldingi* N=546 | .31 | .62 | .96 | .48 | .28 | .72 | .32 | .64 | .76 | .44 | 1.1 | .51 | .68 | .40 | .45 | 1.50 | .88 | .59 |
| *C. confusus* N=227 | .30 | .63 | .99 | .49 | .32 | .70 | .31 | .64 | .78 | .51 | 1.1 | .48 | .71 | .46 | .44 | 1.62 | 1.06 | .66 |
| *C. rhotheus* N=219 | .17 | .73 | 1.03 | .45 | .29 | .62 | .17 | .70 | .65 | .41 | .89 | .24 | .73 | .46 | .27 | 2.75 | 1.75 | .64 |

*Allow separation of species.

canal overlying each mandible and each preopercular bone, respectively. The pores of these canals are the openings of the preopercular-mandibular cephalic sensory systems. The head pore system of the genus *Cottus* has been widely used in systematic studies (Robins and Miller 1957, McAllister and Lindsey 1961, Robins 1954, 1961, McAllister 1964, 1968). Variability is generally in the mental pore condition, with either the two mental pores fused into a single median chin pore or, more often, the median chin pore split into two mental pores (McAllister 1968).

The Clearwater cottids usually had two mental pores and double postmaxillary pores. This condition gave 11 pores on each side of the preopercular-mandibular canal (Tables 4 and 5). Variation from this condition resulted from fusion of the mental pores, absence or addition of one post-

TABLE 3. Extent of body prickles on each of four species of cottids.

| Species | Sample size | Mean range | Mean* | S.E. |
|---|---|---|---|---|
| *C. confusus* | 219 | 2.0–2.4 | 2.1 | 0.2 |
| *C. beldingi* | 546 | 1.0– 1.2 | 1.0 | 0.1 |
| *C. bairdi* | 227 | 4.0– 8.0 | 6.0 | 2.1 |
| *C. rhotheus* | 316 | 11.0–15.0 | 13.1 | 2.2 |

*Based on a scale of 1 to 15. One indicates prickles absent and 15 indicates entire body covered with prickles.

maxillary pore, absence of the third pore from the chin midline, an additional pore above the first preopercular spine, or a combination of these factors. Pores other than those mentioned were occasionally absent.

Variability in number of preopercular-mandibular pores was high only in South Fork Clearwater *C. confusus*. About 73 percent of the counts differed from 11-11 and ranged from 12-12 to 9-9. The counts were symmetrical (10-10, 9-9, 9-1-9) in about 64 percent of the variant individuals. The 10-10 counts resulted from nearly 71 percent of the variant fishes having single postmaxillary pores. The postmaxillary pores were double on one side and single on the other in another 21 percent of the variant fishes. The 9-9 and 9-1-9 counts had a more variable basis. The 9-9 condition generally resulted from single postmaxillary pores plus the absence of another pore from each side (commonly the third pore from the chin midline). The 9-1-9 counts were usually a result of fusion of the mental pores into a single median pore plus single postmaxillary pores.

*Lateral Line.*— The degree of completeness of the lateral line is sometimes useful as a taxonomic character (Robins and Miller 1957, Koli 1969a, McAllister and Lindsey 1961). The lateral line was recorded in this study as complete, incomplete, or interrupted and a number given the position at which the complete line terminated (Table 6). The lateral line in all four species generally extended caudad above the axial line to just slightly behind the extent of the soft dorsal fin. At this point, the lateral line or its remnant was deflected downward to the axial line. If the line were still present beyond this point, it followed the axial line to the hypural plate.

Bailey and Bond (1963) found that the lateral line was generally incomplete or interrupted in *C. confusus*. Specimens from the Clearwater generally had the lateral line ending under the last few soft dorsal rays or slightly behind the extent of the soft dorsal. However, 23 percent of the specimens had the lateral line interrupted. There were usually short segments of lateral line along the axial line anterior to the hypural plate in these specimens.

*Cottus beldingi* usually had the lateral line incomplete or interrupted with 15 percent of all individuals collected having interrupted lateral lines, and less than 5 having complete lateral lines. However, 70-80 percent of the fish from Elk Creek had complete lateral lines.

*Cottus bairdi* usually has a complete or nearly complete lateral line (Bailey and

TABLE 5. Development of postmandibular pore for each of four species of cottids.

| Species | Sample size | Mean range | Mean* | S.E. |
|---|---|---|---|---|
| *C. confusus* | 219 | 4.0–8.2 | 5.2 | 2.0 |
| *C. beldingi* | 546 | 4.0–6.6 | 4.2 | 0.9 |
| *C. bairdi* | 227 | 3.9–4.3 | 4.0 | 0.1 |
| *C. rhotheus* | 316 | 4.0–4.7 | 4.1 | 0.5 |

*Based on a scale of 1 through 12. One indicates postmandibular pores were triple on both sides. Twelve indicates postmandibular pores absent on both sides. Four indicates postmandibular pores double on both sides.

TABLE 6. Mean extent of lateral line for each of four species of cottids.

| Species | Sample size | Mean range | Mean* | S.E. |
|---|---|---|---|---|
| *C. confusus* | 219 | 11.1–18.0 | 16.0 | 2.3 |
| *C. beldingi* | 546 | 10.3–20.3 | 17.6 | 1.8 |
| *C. bairdi* | 227 | 17.3–21.0 | 19.4 | 1.6 |
| *C. rhotheus* | 316 | 18.9–21.0 | 20.8 | 1.1 |

*Based on a scale of 1 to 21. One indicates lateral line ends under first soft dorsal ray. Twenty-one indicates line ends at hypural plate.

TABLE 4. Mean number of preopercular-mandibular canal pores for each of four species of cottids.

| Species | Sample size | Right mean range | Left mean range | Right mean | Left mean | Right S.E. | Left S.E. |
|---|---|---|---|---|---|---|---|
| *C. confusus* | 219 | 9.7–11.2 | 9.8–11.2 | 10.7 | 10.7 | 0.6 | 0.6 |
| *C. beldingi* | 546 | 10.5–11.3 | 10.2–11.7 | 10.9 | 10.9 | 0.3 | 0.4 |
| *C. bairdi* | 227 | 10.8–11.3 | 10.7–11.2 | 11.0 | 11.0 | 0.2 | 0.3 |
| *C. rhotheus* | 316 | 10.2–11.1 | 10.4–11.1 | 10.9 | 10.9 | 0.4 | 0.3 |

Dimick 1949). The lateral line usually ended just anterior to the hypural plate in Clearwater specimens but was complete in about 18 percent of the individuals.

*Cottus rhotheus* generally has a complete lateral line except in very small individuals (Bailey and Dimick 1949). The lateral line was complete or nearly complete in all Clearwater specimens.

*Cottus rhotheus* could generally be distinguished from the other species by the completeness of the lateral line, but the other species could not be distinguished from each other. In all species the development of the lateral line was related to age, with greater lateral line development in larger, mature individuals rather than in smaller fish.

*Preopercular Armature.*— The number of preopercular spines is constant enough in some species of cottids to be useful as a taxonomic character. In other species, this character is highly variable (Bailey and Bond 1963, Robins and Miller 1957).

*Cottus beldingi* was reported to have a single preopercular spine (Eigenmann and Eigenmann 1891, Hubbs and Schultz 1932). This character varied from one to more than three spines in the Clearwater material. The mode for the species was one spine plus variable combinations of bumps, but the median value was more than two spines. Variability was high at all locations.

Variability in spinous condition was also high in *C. confusus*. *Cottus confusus* from the Lochsa, Selway, and North Fork Clearwater usually had two or three spines with various combinations of bumps. Few individuals with only one spine (16 percent) were seen. In contrast, individuals from the South Fork Clearwater had no spine, a single spine, or a single spine plus weakly developed bumps.

Variation in the preopercular armature of *C. rhotheus* and *C. bairdi* was relatively slight. Most specimens of *C. rhotheus* had three spines plus bumps or four spines. Typically, *C. bairdi* had three spines and either no bumps or weakly developed bumps.

Species did not differ sufficiently in preopercular armature to allow identification, but development of the preopercular armature did allow identification of two groups of two species (Table 7).

## CONCLUSIONS

Body color was variable within and among species and was generally related to substrate color or breeding condition.

No single meristic character allowed differentiation among these species. Pectoral ray counts allowed separation into two groups of two species but did not separate the species within the groups. *Cottus beldingi* and *C. confusus* usually had 13 or 14 pectoral rays, whereas *C. bairdi* and *C. rhotheus* usually had 15 or 16 rays.

The development of palatine teeth usually separated the four species, but unusual specimens could not be identified with this character. *Cottus beldingi* generally lacked palatine teeth, *C. confusus* usually had weakly developed palatine teeth, *C. bairdi* had well-developed palatine teeth with a small separation between the vomerine and palatine teeth, and *C. rhotheus* had the vomerine and palatine teeth cojoined and well developed.

Most body proportions failed to separate species. However, ratios involving caudal peduncle depth usually separated *C. rhotheus* and *C. bairdi* from other species and from each other.

The development of body prickles generally separated the four species. *Cottus beldingi* lacked prickles, *C. confusus* had a small patch of axial prickles, *C. bairdi* had axial prickles plus a row of prickles above the lateral line, and *C. rhotheus* had prickles over most of the body. However, within each species, some fish showed the condition typical of one of the other species.

TABLE 7. Development of projections from the preopercular bone for each of four species of cottids.

| Species | Sample size | Mean range | Mean° | S.E. |
|---|---|---|---|---|
| *C. confusus* | 219 | 8.0–28.9 | 24.3 | 6.5 |
| *C. beldingi* | 546 | 15.9–27.9 | 23.4 | 5.8 |
| *C. bairdi* | 227 | 30.6–34.5 | 32.2 | 1.7 |
| *C. rhotheus* | 316 | 32.4–34.7 | 33.2 | 1.2 |

°Based on a scale of 1 to 35. One indicates no projections on preopercular bone. Thirty-five indicates four spines on preopercular bone.

Larger *C. rhotheus* had apparently begun to resorb prickles and approximated the condition typical of *C. bairdi*.

The development of the lateral line usually separated *C. rhotheus* from the other species if adult specimens were used. The lateral line was usually complete in *C. rhotheus* and interrupted or incomplete in the other species.

The preopercular armature was usually better developed in *C. bairdi* and *C. rhotheus* than in *C. beldingi* or *C. confusus*. The two groups of two species could not be separated using this character.

No single character allowed separation among the species of cottids from the Clearwater. However, the characters studied could, when used in combination, give reasonable accuracy in identification.

Key to the Clearwater Drainage *Cottus*

1. Palatine teeth generally present. Prickles developed at least in the axial position. Lateral line variable ..... 2
   Palatine teeth usually absent; if present, commonly only developed on one side. Body naked. Lateral line interrupted or incomplete, rarely complete. Found in the main river and lower tributaries ..... *C. beldingi*
2(1). Prickles covering most of the body except in large specimens. Lateral line usually complete. Palatine teeth well developed, usually conjoined with the vomerine teeth. Caudal peduncle to total length ratio about 0.05. Skin over the eye nubbly. Body saddles extending cephalad at an angle to the long axis of the body. Restricted to the main river and the larger tributaries ..... *C. rhotheus*
   Prickles restricted to an axial patch or an axial patch plus a bar paralleling the lateral line. Palatine teeth usually present. Lateral line usually incomplete, rarely complete ..... 3
3(2). Prickles restricted to an axial patch. Palatine teeth usually present and weakly developed, sometimes absent in restricted locations. Lateral line usually ending under the last few soft dorsal rays, sometimes interrupted, with pores on the axial line just anterior to the hypural plate. Caudal peduncle to total length ratio about 0.07. Usually 13 or 14 pectoral rays. Restricted to the headwater areas at the upper portions of the drainage ..... *C. confusus*
   Prickles usually an axial patch plus a bar above the lateral line. Palatine teeth strongly developed with only a slight separation between palatine and vomerine tooth patches. Lateral line usually incomplete, ending just anterior to the hypural plate, sometimes complete. Caudal peduncle to total length ratio about 0.06. Usually 15 to 16 pectoral rays. Skin over eye not nubbly. Dorsal saddles perpendicular to the long axis of the body. Restricted to the main river and larger tributaries ..... *C. bairdi*

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